HOW MACHINE LEARNING CAN HELP US ESTIMATE CROP WATER DEMAND AND INFORM IRRIGATION DECISIONS?

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SELF INTRODUCTION

2014-2018

Hohai University

- ❑Nanjing, China
- ❑Bachelor of Engineering in Agriculture Water Management & Business Administration

2018-2020

Texas A&M University

- ❑College Station, Texas
- ❑Master of Science in Civil Engineering - Water Resource Management
- ❑Influence of land-use change and agriculture practices on water carbon and energy fluxes

2020-2024

University of Nebraska Lincoln

- ❑Lincoln, Nebraska
- ❑Doctor of Philosophy in Biological Engineering- Water Resource Management
- ❑Integrating Water and Nitrogen Management for Sustainable Agriculture: Optimizing Resource Use Efficiency and Maximizing Crop Productivity

2024-NOW

Columbia University

- ❑Lamont Doherty Earth Observatory
- ❑Postdoc scientist
- ❑leveraging modeling and remote sensing tools to estimate soil carbon, water, and nitrogen cycling,

WHY IRRIGATION MATTERS?

Growing challenges!

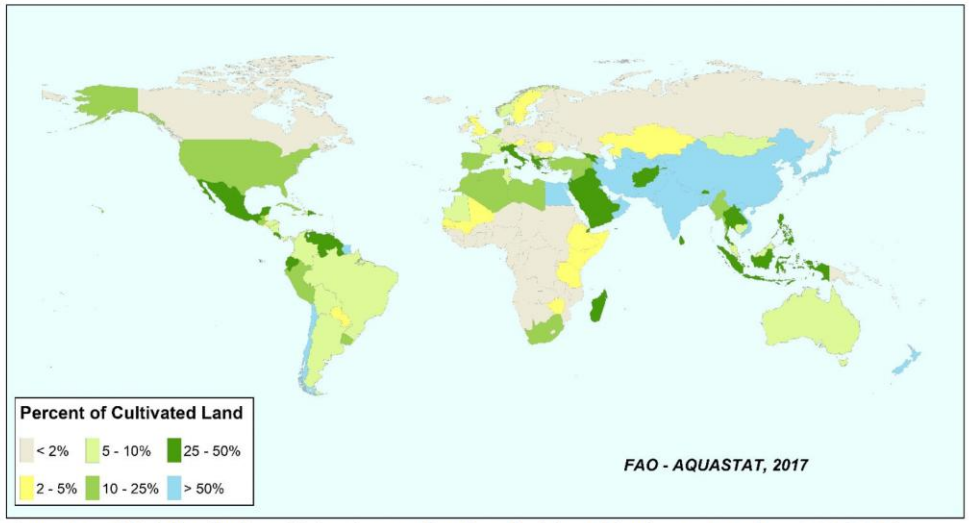


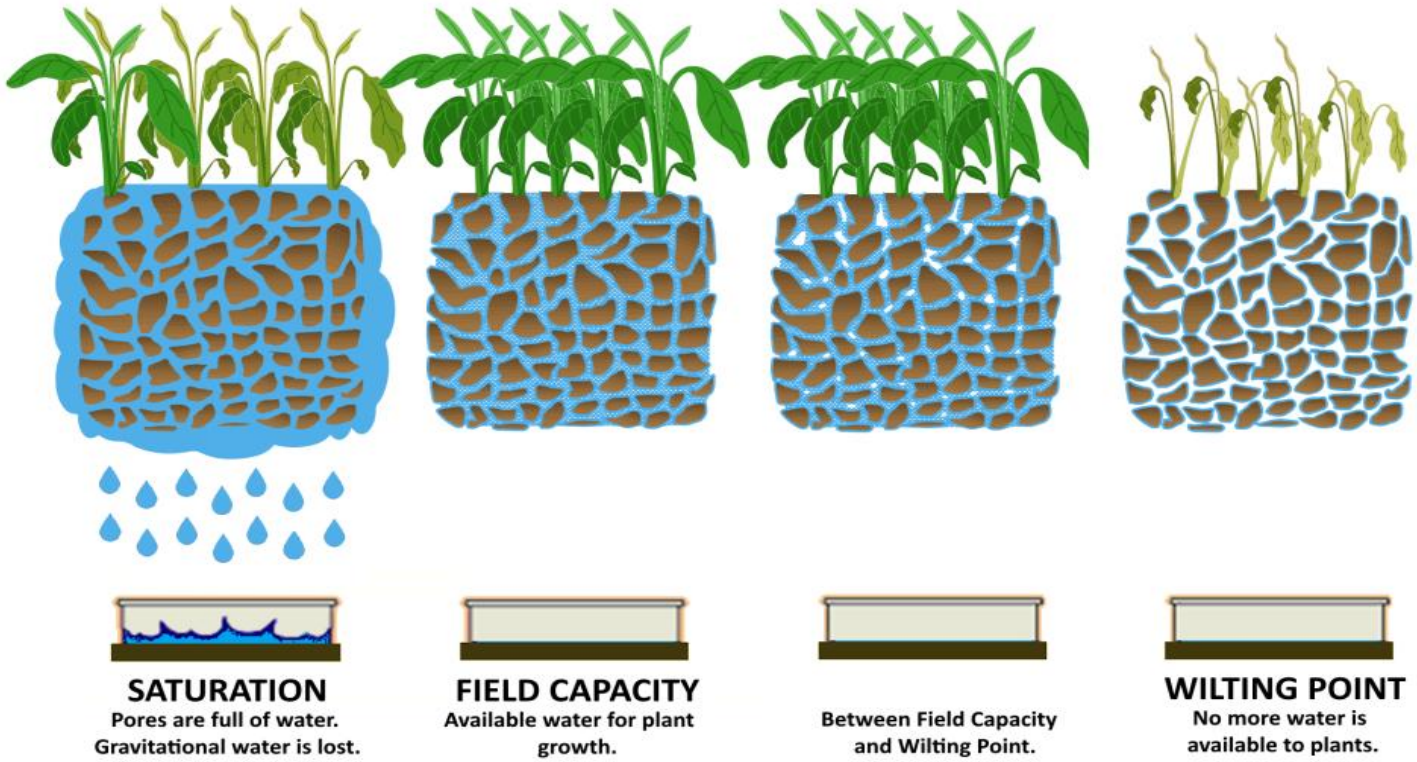
Figure 1.1. Global distribution of irrigation as a fraction of cultivated land area. Data from FAO (2021).

- Irrigation is essential for global food security, providing stability in crop production.
- Irrigation enables agriculture in otherwise dry or marginal regions.
- Irrigation consumes ~70% of global freshwater withdrawals, creating growing competition with urban and industrial use.
- Traditional irrigation methods often waste water and fail to match plant water needs.
- Poorly managed irrigation can lead to soil erosion, salinization, and water quality degradation.
- Climate change and population growth are increasing the demand for efficient irrigation systems.

TYPES OF IRRIGATION SYSTEM

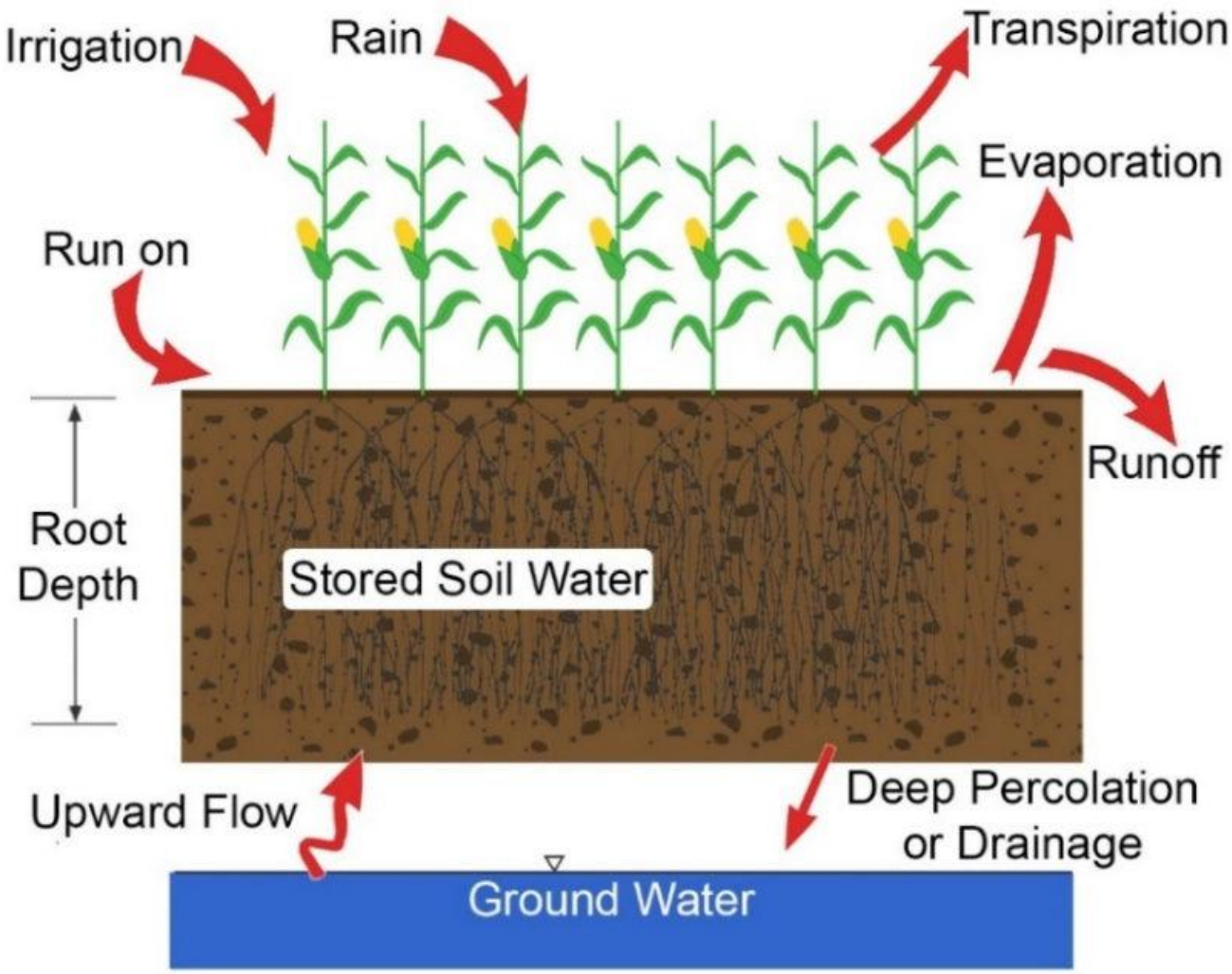
- Surface Irrigation
- Sprinkler Irrigation
- Micro irrigation – Drip irrigation

VARIABLE RATE IRRIGATION MANAGEMENT



AVAILABLE SOIL WATER CONTENT

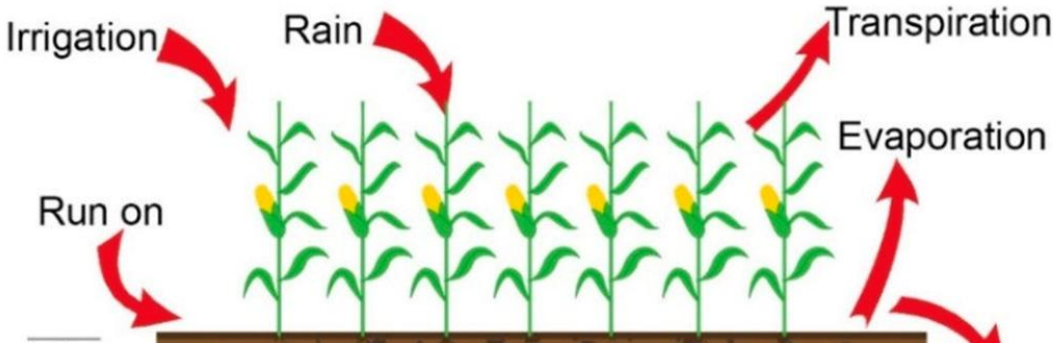
WHERE DOES THE WATER COME AND GO?



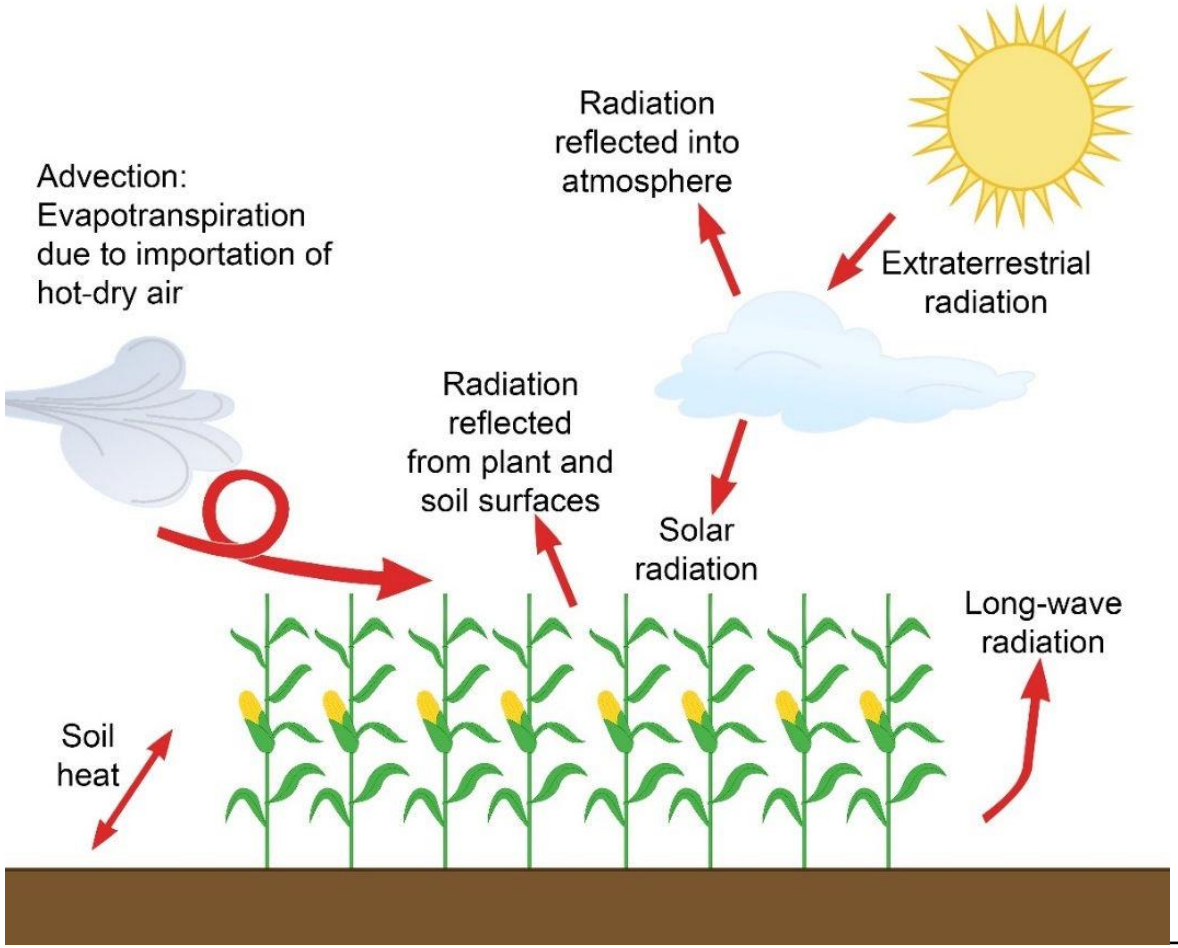
PLANT WATER USE - ET

Evaporation + **Transpiration** = **Evapotranspiration**

- *Evapotranspiration* is the term used to describe ecosystem water use
- *Evaporation* is the liquid turns into a gas at temperatures below its boiling point from a wet soil surface progresses
- *Transpiration* is vapor lost from plant leaves in the stomatal cavity and from the stomata into the atmosphere



PLANT WATER USE - DRIVERS



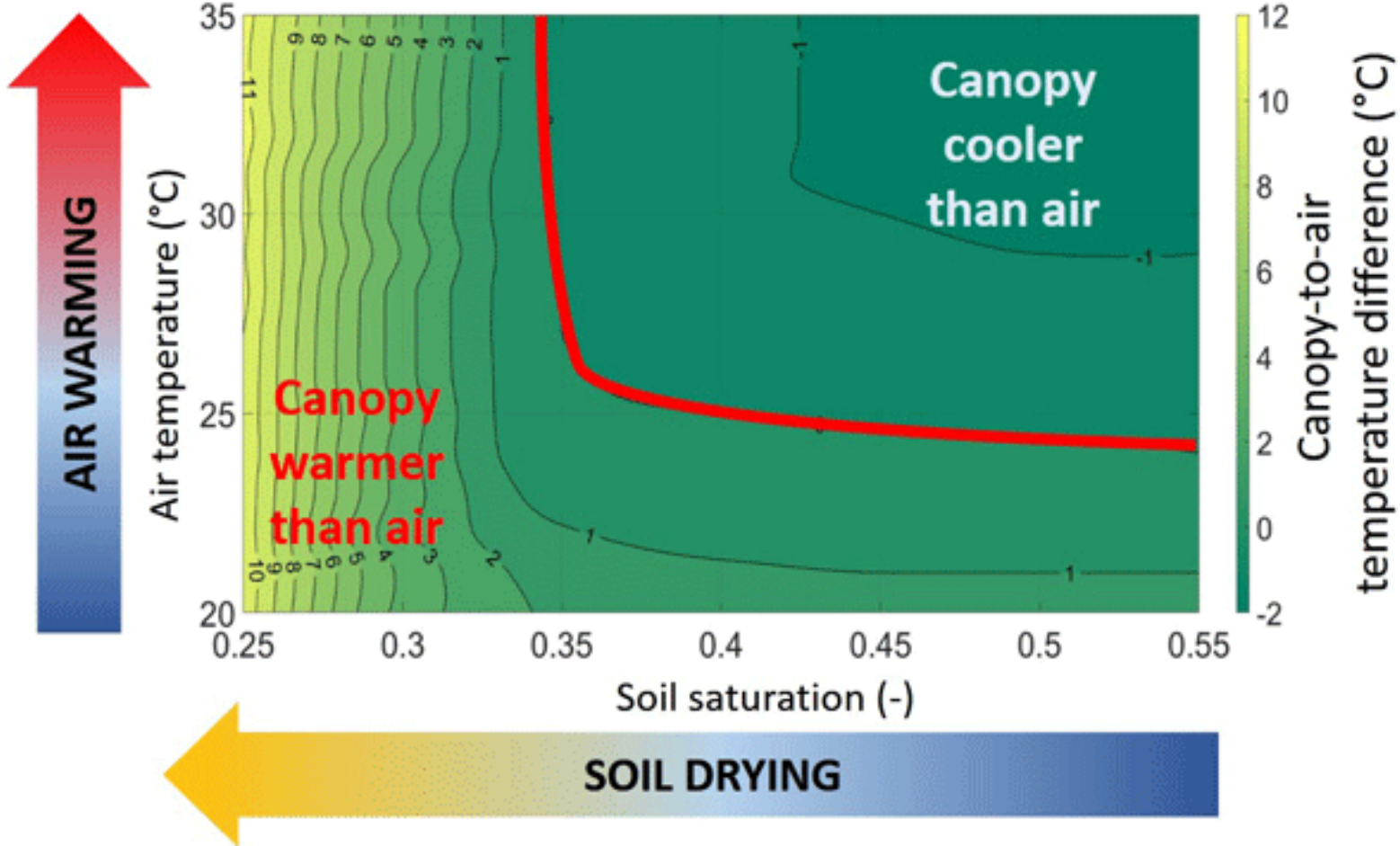
- It is important to understand how plant use water and how weather influence water use
- Key words:

Net Radiation

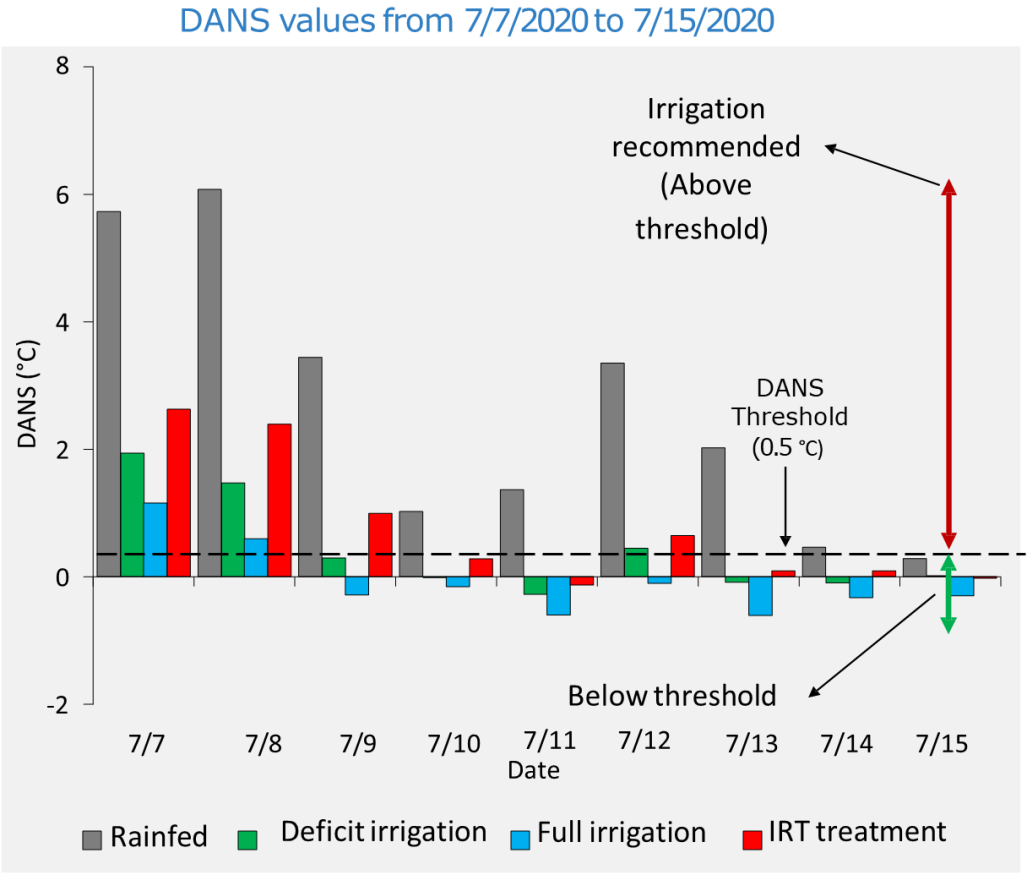
Temperature

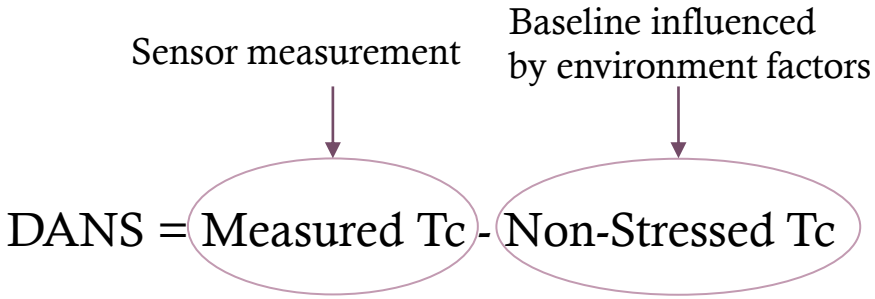
Soil water availability

Wind speed


AIR WARMING
Air temperature (°C)
35
30
25
20
Canopy
cooler
than air
Canopy
warmer
than air
0.25
0.3
0.35
0.4
0.45
0.5
0.55
Soil saturation (-)
SOIL DRYING
12
10
8
6
4
2
0
-2
Canopy-to-air
temperature difference (°C)

DEGREES ABOVE NON-STRESSED (DANS) INDEX





- Used for irrigation scheduling based on canopy temperature.
- **Application**
  - If **DANS > 0.5°C**, irrigation is recommended.
  - If **DANS < 0.5°C**, no irrigation needed.
  - Helps optimize water use efficiency.

EXAMPLE

- Dataset preparation – Download from GEE
- Recurrent Neural Network and Random Forest model

WEATHER DATA OPTIONS

- Local level dataset: MESONET, https://nysmesonet.org/
- Regional/Continental/Global dataset:
  - NLDAS: https://developers.google.com/earth-engine/datasets/catalog/NASA_NLDAS_FORA0125_H002
  - GRIDMET: https://developers.google.com/earth-engine/datasets/catalog/IDAHO_EPSCOR_GRIDMET
  - PRISM: https://developers.google.com/earth-engine/datasets/catalog/OREGONSTATE_PRISM_AN81d#description